Tuberculin Testing and Risk of Tuberculosis Infection Among New York City Schoolchildren

Celine R. Gounder, ScM*; Cynthia R. Driver, RN, MPH*; Jerod N. Scholten, MPH*; Huimin Shen, MSPH‡; and Sonal S. Munsiff, MD*

ABSTRACT. ***Objectives.*** **To assess adherence to a 1996 health policy change, which discontinued mandatory tuberculin skin testing (TST) of new entrants to NYC primary schools and continued mandatory testing of new entrants to secondary schools.**

Methods. **The proportion tested before (1991–1995) and after (1996–1998) the change in health policy was determined. Factors associated with TST positivity and the cost of continued testing were assessed.**

Results. **A total of 76.6% of 551 636 new entrants to primary schools were tested in 1991–1995; slightly fewer, 71.1% of 339 958, were tested in 1996- 1998. Among new entrants to secondary schools, 31.0% of 106 463 were tested in 1991–1995 and 51.4% of 53 762 were tested in 1996–1998. The proportion who were TST-positive continued to decrease after 1996 to 1.2% among primary and 9.7% among secondary schoolchildren in 1998. Older age and birth outside the United States were associated with TST positivity. The estimated minimum cost of continued testing in primary schools was $123 152 per tuberculosis case prevented.**

Conclusion. **An approach aimed at reducing testing of children at low risk for latent tuberculosis infection did not decrease testing of younger children. More important, older children who were more likely to be born in countries of high tuberculosis incidence were not tested. Additional efforts are needed to increase awareness among medical and school personnel to decrease testing among children who do not have risk factors for latent tuberculosis infection and to increase tuberculin testing of children who are entering school for the first time at the secondary level and do have risk factors for tuberculosis infection. *Pediatrics* 2003;111:e309–e315. URL: http://www.pediatrics.org/cgi/content/full/111/4/e309; *tuberculosis infection, children, tuberculosis testing, screening.***

ABBREVIATIONS. NYC, New York City; TST, tuberculin skin test(ing); LTBI, latent tuberculosis infection; OR, odds ratio; CI, confidence interval.

The Institute of Medicine recently published recommendations on how to achieve the elimination of tuberculosis in the United States. The report calls for "accelerating the rate of decline of tuberculosis by increasing efforts at targeted tuberculin testing and treatment of latent tuberculosis infection."[1] To achieve the objectives of these recommendations, tuberculosis control programs need to assess the risk of infection in groups that are receiving tuberculin testing, determine whether such efforts are warranted, and, if not, redirect resources to higher yield efforts.

Between 1978 and 1992, the incidence of tuberculosis tripled in NYC, from 17.2 per 100 000 to 52.0 per 100 000, exceeding 200 per 100 000 in some neighborhoods.[2] In 1990, the New York City Department of Health mandated tuberculosis screening for all new entrants to NYC schools in response to the increasing incidence of tuberculosis in NYC and nationwide.[3] Subsequent analysis of the results of tuberculin skin testing (TST) of new school entrants from 1991 through 1993 showed that primary school students, particularly those who were US-born, were at low risk of latent tuberculosis infection.[4] Therefore, in 1996, the NYC Health Code was amended to require TST of only new entrants to secondary schools to reduce unnecessary screening of primary schoolchildren at low risk of latent tuberculosis infection.[5]

In this article, we review the results of TST of schoolchildren performed after the 1996 Health Code amendment to assess the extent to which the change in testing practices was followed and to determine whether changes in prevalence of tuberculosis infection justify continued testing in secondary school students. We also examined factors associated with TST positivity.

From the *Tuberculosis Control Program and the ‡School Children and Adolescent Health Program, New York City Department of Health, New York, New York.

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Reprint requests to (C.R.D.) Epidemiology, Tuberculosis Control Program, New York City Department of Health, 225 Broadway, 22nd Floor, New York, NY 10007. E-mail: cdriver@health.nyc.gov

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METHODS

The survey methods for tuberculin testing and the analysis of the prevalence of latent tuberculosis infection in new school entrants in NYC have been reported elsewhere.[4] Briefly, before admission to school, NYC Health Code requires that all NYC children, including all new entrants to secondary schools (ie, first-time entrants to a NYC school after the sixth grade), have a physical examination, which includes a Mantoux tuberculin test. The results of the tuberculin testing are recorded on a standard form submitted to the health department. The form collects demographic information including date of birth, gender, place of birth, race and ethnicity, grade level, and school type (public or state-run versus private). All information is entered into a database maintained by the School Children and Adolescent Health Program in the New York City Health Department.

The study population included the cohort of all new school entrants who had a tuberculin test placed by Mantoux technique and read within 48 to 72 hours after the injection of 5 tuberculin units of purified protein derivative during 1 of 8 school years, 1991 through 1998. During the earlier study years, NYC clinical guidelines defined a positive tuberculin test as an induration reaction

≥10 mm in most people, including people from medically underserved, low-income neighborhoods. Subsequently, risk-based cutoffs have been recommended such that the definition of a positive skin test (≥5 mm, ≥10 mm, or ≥15 mm) depends on the individual's risk for tuberculosis infection. Therefore, analyses using both the 10-mm and 15-mm cutpoints were performed. The proportion of students for whom tuberculin test results were available (response rate) was determined by dividing the number who were tested and whose results were known by the number of new entrants estimated by the New York City Board of Education. The completeness of the variables was examined for each school year. To improve the completeness of information on country of birth, the study file was matched to the New York City Birth Registry to determine which children were born in NYC.

New school entrants for whom place of birth was known were classified into those born in the United States (including Puerto Rico and the US Virgin Islands) and those born outside the United States (described here as non–US-born students) and classified by birth in a country with high tuberculosis disease rates (defined as countries estimated as having ≥20 acid-fast-bacilli sputum smear positive cases per 100 000 people)[6–8] (Angela Hinds, Caribbean Epidemiology Centre, personal communication) and birth in a country with low (<80%) or high (≥80%) BCG vaccination coverage rates.[9] BCG vaccination coverage in the country of birth was used rather than history of BCG vaccination because the quality of the data on the latter was less reliable and complete. Because BCG vaccination is rarely used in the United States, new entrants who were born in the United States and who reported having received BCG vaccination were excluded from the analyses. The annual risk of infection was calculated.[10,11]

Unique identifiers including name and date of birth of all new school entrants were also matched to the health department's tuberculosis case registry to identify whether any confirmed cases of tuberculosis disease had developed by April 1, 2000. Tuberculosis disease was defined as the isolation of *Mycobacterium tuberculosis* in culture from any anatomic site or, in the absence of bacteriologic confirmation, clinical or radiographic findings consistent with tuberculosis disease. Potential infectiousness was determined on the basis of disease site, sputum smear microscopy result, and culture confirmation; culture-confirmed tuberculosis was considered noninfectious if the patient had extrapulmonary disease only (except for laryngeal tuberculosis) or was younger than 6 years.

Bivariate analyses were performed using both 10-mm and 15-mm cutpoints to define a positive TST reaction. For the logistic regression multivariate analyses, a positive TST was defined as a reaction with an induration ≥10 mm. Using either the SAS System[12] or Epi Info,[13] proportions were compared with the Yates corrected and Mantel-Haenszel χ^2 statistic or Fisher exact 2-tailed test. Continuous data were compared with the Student *t* test or, if not normally distributed, with the Wilcoxon 2-sample test. Multivariate analyses of correlates of TST positivity were performed with logistic regression. Multivariate analyses of 5-year incidence of tuberculosis infection among 5-year-olds in each cohort were performed with Poisson regression. For determining whether digit preference in measuring the induration reaction may have affected the results of the analyses, multivariate models were performed using 10-mm, 15-mm, and 17-mm cutpoints, respectively. Factors associated with TST positivity did not change significantly from previous analysis,[4] and therefore only salient factors are presented.

Separate multivariate models were constructed for US-born and non–US-born children because the risk factors for each group differed. Although we found evidence for interaction between tuberculosis incidence in country of birth and BCG vaccination coverage in country of birth, these interaction terms did not change the model considerably and so were not included in the final model.

An estimate of the cost of excess testing was made using the method recently described by the Institute of Medicine.[1] We assumed that all children who were TST-positive received a chest radiograph and clinical evaluation. It was also assumed that 80% of those found to be TST-positive would receive isoniazid treatment for latent tuberculosis infection (LTBI), recognizing that some parents would refuse treatment and that others would have contraindications for treatment. It was also assumed that none of the children had HIV infection. For estimating the cost of TST to prevent each case of TB disease, treatment of LTBI for 9 months was assumed to be 75% effective in preventing tuberculosis, based on effectiveness studies that showed 75% effectiveness of a 12-month regimen and that optimum protection is achieved by 9 or 10 months of treatment.[14,15] Because this was a young population, we assumed no serious adverse reactions that caused discontinuation of treatment of LTBI.[16] Finally, the 5-year risk of developing tuberculosis if no treatment for LTBI was given to TST-positive children (2.4%) was estimated from data from the US Public Health Service trial of isoniazid therapy among household contacts.[15] Administrative costs, the cost of adverse reactions, and the cost of additional transmission of tuberculosis from the TST-positive children are not accounted for in these estimates. This project was approved by the New York City Department of Health Institutional Review Board.

RESULTS

Of 913 204 records in the 1991–1998 new school entrants database, 59 009 (6.5%) were excluded for the following reasons: unknown tuberculin test results (n = 10 983), unknown age (n = 46 684), and/or reported as having been BCG vaccinated but were born in the United States, where BCG is not routinely administered (n = 2662); 1320 met more than 1 exclusion criterion. Of the remaining 854 195 new school entrants, 65 912 (7.7%) were duplicates and removed from subsequent analyses. Thus, 788 283 new school entrants were retained in the analyses presented here.

In the 1991–1995 school years, the rate of tuberculin testing among the estimated student population in public schools was 76.6% (422 525 of 551 636) for primary school new entrants and 31.0% (33 007 of 106 463) of secondary school new entrants. For school years 1996–1997 through 1998–1999, the testing rate was 71.1% (241 570 of 339 958) in primary schools and 51.4% (27 651 of 53 762) in secondary schools. Of the estimated student population, records were not available for 138 615 (13%). For all variables studied, completeness of the data were lower in 1998–1999 than in other school years; the percentage with no response in 1998–1999 for place of birth, gender, race, and grade level was 28%, 4%, 39%, and 14%, respectively.

The number of positive TST by characteristics of the 788 283 new school entrants retained for analyses are shown in Table 1. The majority of new school entrants were between 3 and 5 years of age (68.4). Almost half of new school entrants for whom race or ethnicity was reported were Hispanic or Black; however, 31.8% did not have race reported. A total of 80.3% of new school entrants were enrolled in public schools, whereas 12.4% were enrolled in private schools. A total of 14.2% of students were non–US-born, and 65.3% of students were US-born. For the remaining 20.5% of students, birthplace was not reported or identified through match with the NYC birth registry.

The prevalence of TST positivity among all new school entrants was 2.2% (17 700 of 788 283) when a 10-mm cutpoint was used and 1.0% (7654 of 788 283) when a 15-mm cutpoint was used. Factors associated with having a positive TST were not altered when a 15-mm cutpoint was used; thus, subsequent analyses were performed using a 10-mm cutpoint. Non-US birth was the factor most strongly associated with TST positivity (odds ratio [OR]: 21.0; 95% confidence

TABLE 1. TST Results Among New School Entrants in NYC by Selected Characteristics, 1991–1998 School Years (n = 788 283)

	Tested (n [%])	≥10 mm	
		TST-Positive (n [%])	OR (95% CI)
Age (y)			
3–5	539 121 (68.4%)	4675 (0.9%)	1.0
6–11	178 688 (22.7%)	6224 (3.5%)	4.1 (4.0–4.3)
12–16	70 474 (8.9%)	6801 (9.7%)	12.2 (11.8–12.7)
Race/ethnicity			
White	120 160 (15.2%)	1968 (1.6%)	1.0
Black	152 686 (19.4%)	2959 (1.9%)	1.2 (1.1–1.3)
Asian	59 039 (7.5%)	3139 (5.3%)	3.4 (3.2–3.6)
Hispanic	188 282 (23.9%)	4018 (2.1%)	1.3 (1.2–1.4)
Native American	1381 (0.2%)	34 (2.5%)	1.5 (1.1–2.1)
Other	16 271 (2.1%)	472 (2.9%)	1.8 (1.6–2.0)
Unknown	250 464 (31.8%)	5110 (2.0%)	1.3 (1.2–1.3)
Type of school			
Nonpublic	97 517 (12.4%)	689 (0.7%)	1.0
Public	632 783 (80.3%)	15 475 (2.5%)	3.5 (3.3–3.8)
Unknown	57 983 (7.4%)	1536 (2.7%)	3.8 (3.5–4.2)
School level			
Primary	664 095	9689 (1.5%)	1.0
Secondary	60 658	6425 (10.6%)	8.0 (7.7–8.3)
Unknown	63 530	1586 (2.5%)	1.7 (1.6–1.8)
Birthplace			
NYC-born	451 206 (57.2%)	2028 (0.5%)	1.0
Other US-born	63 799 (8.1%)	525 (0.8%)	1.8 (1.7–2.0)
Foreign-born	112 081 (14.2%)	10 413 (9.3%)	22.7 (21.6–23.8)
Unknown	161 197 (20.5%)	4734 (2.9%)	6.7 (6.4–7.1)
TB incidence in birthplace			
Low (<20 AFB sputum smear positive cases per 100 000)	552 468 (70.1%)	5470 (1.0%)	1.0
High (≥20 AFB sputum smear positive cases per 100 000)	72 895 (9.3%)	7297 (10.0%)	11.1 (10.7–11.5)
Unknown	162 920 (20.7%)	4933 (3.0%)	3.1 (3.0–3.2)
BCG coverage in birthplace			
Low (<80%)	550 526 (69.9%)	5075 (0.9%)	1.0
High (≥80%)	74 869 (9.5%)	7687 (10.3%)	12.3 (11.9–12.8)
Unknown	162 888 (20.7%)	4938 (3.0%)	3.4 (3.2–3.5)
History of BCG vaccination			
No	389 857 (49.5%)	2496 (0.6%)	1.0
Yes	26 641 (3.4%)	4088 (15.3%)	28.1 (26.7–29.6)
Unknown	371 785 (47.2%)	11 116 (3.0%)	4.8 (4.6–5.0)
Total	788 283 (100.0%)	17 700 (2.2%)	—

interval [CI]: 19.5–22.5); therefore, separate multivariate models are provided for US- and non–US-born children. Among US-born new entrants, the factors that were independently associated with TST positivity were age, race, and type of school attended (Table 2). Compared with 3- to 5-year-olds, 12- to 16-year-olds were nearly 4 times more likely to be TST-positive. US-born Asian students were 3 times more likely to be TST-positive than white students. Public school students were 1.5 times more likely to be TST-positive than private school students.

Among non–US-born students, the effect of tuberculosis incidence in the country of birth on TST positivity varied according to the rate of BCG vaccination in the country of birth. Among children who were born in countries with low BCG coverage, those from high tuberculosis incidence countries were 18 times more likely to have a positive TST than children from low tuberculosis incidence countries (OR: 17.5; 95% CI: 16.5–18.5). Conversely, among children who were born in countries with high BCG coverage, children from high tuberculosis incidence countries were only slightly more likely to be TST-positive than children from low tuberculosis incidence countries (OR: 1.1; 95% CI: 1.1–1.2). The factors that were independently associated with TST positivity in non–US-born children were age, type of school, tuberculosis incidence, and BCG coverage in the country of origin (Table 3). Compared with students who were born in countries with low tuberculosis incidence, students who were born in countries with high tuberculosis incidence were 1.6 times more likely to have a positive TST. Compared with students who were born in countries with low BCG vaccination coverage, students who were born in countries with high BCG vaccination coverage were at 1.3 times greater risk of being TST-positive.

Although older age was independently associated with having a positive TST in both US- and non–US-born children, new entrants to secondary schools (ie, children who were older at time of first entry to an NYC school) were more likely to be non–US-born. Only 13.6% (78 197 of 574 091) of new entrants to primary schools were non–US-born, whereas a remarkable 63.9% (33 884 of 52 995) of new entrants to secondary schools were non–US-born. The propor-

TABLE 2. Multivariate Analysis of Social and Demographic Characteristics and TST Positivity of US-Born New School Entrants in NYC, School Years 1991–1998 (n = 515 005*)

	Tested (n [%])	TST+ ≥10 mm (n [%])	$OR_{adjusted}$ (95% CI)
Age (y)			
3–5	413 223 (80.2%)	1721 (0.4%)	1.0
6–11	82 671 (16.1%)	539 (0.7%)	1.6 (1.4–1.7)
12–16	19 111 (3.7%)	293 (1.5%)	3.7 (3.3–4.2)
Race			
White	94 074 (18.3%)	246 (0.3%)	1.0
Black	116 777 (22.7%)	626 (0.5%)	1.8 (1.5–2.1)
Asian	27 946 (5.4%)	213 (0.8%)	2.8 (2.4–3.4)
Hispanic	136 500 (26.5%)	769 (0.6%)	1.9 (1.7–2.2)
Native American	912 (0.2%)	4 (0.4%)	1.6 (0.6–4.3)
Other	8800 (1.7%)	45 (0.5%)	1.8 (1.3–2.5)
Unknown	129 996 (25.2%)	650 (0.5%)	1.7 (1.5–2.0)
Type of school			
Nonpublic	76 277 (14.8%)	236 (0.3%)	1.0
Public	406 089 (78.9%)	2149 (0.5%)	1.6 (1.4–1.8)
Unknown	32 639 (6.3%)	168 (0.5%)	1.5 (1.2–1.8)
Total	515 005 (100.0%)	2553 (0.5%)	—

* For 20.5% of students, birthplace was not reported.

TABLE 3. Multivariate Analysis of Social and Demographic Characteristics and TST Positivity of Foreign-Born New School Entrants in NYC, School Years 1991–1998 (n = 112 081*)

	Tested (n [%])	TST+ ≥10 mm (n [%])	$OR_{adjusted}$ (95% CI)
Age (y)			
3–5	29 758 (26.6%)	1580 (5.3%)	1.0
6–11	48 439 (43.2%)	3911 (8.1%)	1.5 (1.5–1.6)
12–16	33 884 (30.2%)	4922 (14.5%)	3.0 (2.8–3.2)
Type of school			
Nonpublic	5021 (4.5%)	260 (5.2%)	1.0
Public	97 960 (87.4%)	9273 (9.5%)	1.7 (1.5–1.9)
Unknown	9100 (8.1%)	880 (9.7%)	1.7 (1.5–2.0)
TB incidence in birthplace			
Low	37 463 (33.4%)	2917 (7.8%)	1.0
High	72 895 (65.0%)	7297 (10.0%)	1.6 (1.5–1.6)
Unknown	1723 (1.5%)	199 (11.6%)	2.3 (1.5–3.7)
BCG coverage in birthplace			
Low (<80%)	35 521 (31.7%)	2522 (7.1%)	1.0
High (≥80%)	74 869 (66.8%)	7687 (10.3%)	1.3 (1.3–1.4)
Unknown	1691 (1.5%)	204 (12.1%)	0.9 (0.6–1.4)
Total	112 081 (100.0%)	10 413 (9.3%)	—

* For 20.5% of students, birthplace was not reported.

tion of secondary school new entrants who were TST-positive was 1.5% and 14.5%, respectively, among US- and non–US-born children.

The percentage of new entrants who were TST-positive decreased significantly after the 1992–1993 school year. Among primary school entrants, the percentage who were TST-positive decreased 40%, from 1.7% in 1992 to 1.2% in 1998 (χ^2 for trend 121.15, $P < .001$). Among new entrants to secondary schools, the percentage who were TST-positive decreased 25% during the same period, from 11.9% to 9.7% (χ^2 for trend 30.24, $P < .001$). The estimated annual risk of tuberculosis infection for 5-year-olds born in NYC ranged from 0.062% in 1991 to 0.083% in 1998; this trend was not linear (χ^2 for trend, $P = .2$). Depicted in Fig 1 is the proportion who were TST-positive by birth country, school level, and cutpoints for defining TST-positive.

Excluding 88 new school entrants with tuberculosis before mandatory tuberculin testing, 149 (0.02%) of 788 283 new school entrants received a diagnosis of having active tuberculosis subsequent to their entrance medical evaluation. The proportion per year decreased significantly from 0.03% to 0.01% during the study period (χ^2 for trend $P = .009$). The median age of the children with active tuberculosis at the time of diagnosis was 6 years (range: 3–21 years). Of the 149 students with tuberculosis disease, 61 (40.9%) were TST-positive at the time of their school entrance medical evaluation. Twenty-two (14.8%) tuberculosis cases were diagnosed within 3 months of the children's having undergone tuberculin testing, and 127 (85.2%) cases were diagnosed with tuberculosis >3 months after the children's having undergone tuberculin testing. Of these 127, 39 (30%) were TST-positive at the time of medical evaluation. Six were prescribed treatment for LTBI; the reasons for failure to prescribe or complete treatment for LTBI are not known. Thirty-one of these 39 TST-positive children were younger than 12 years, 16 of whom would have met the criteria for tuberculin screening because they were recent arrivals from a high-incidence country. Of all of the active tuberculosis cases, only 23 (15.4%) cases were culture-positive, and the remaining 126

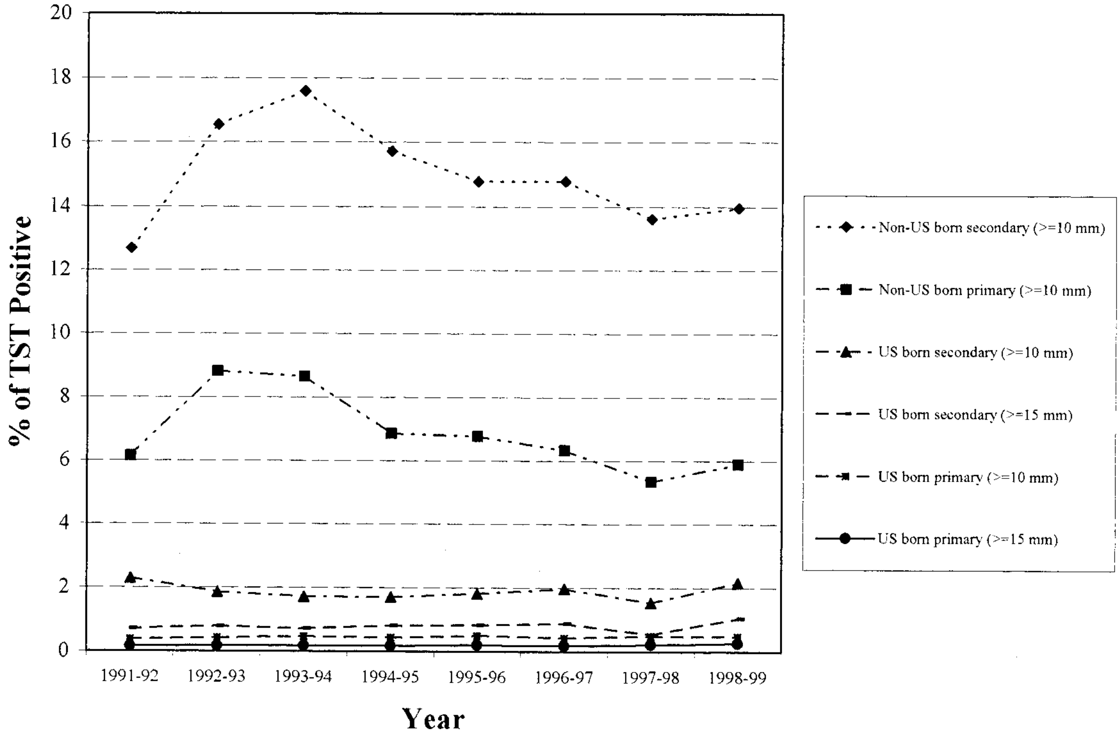

Fig 1. Percentage of new school entrants whose TST was positive, by school level and country of origin, New York City.

(84.6%) cases were verified on the basis of clinical response to treatment. Of the culture-confirmed tuberculosis cases, 20 had pulmonary disease and 3 had extrapulmonary disease only. Children with culture-confirmed pulmonary tuberculosis were older at diagnosis than those with clinically confirmed or extrapulmonary disease (median: 12 vs 5 years; $P < .001$). Among children with tuberculosis disease for whom birthplace was known, 73 (50%) were non–US-born. Among the 627 086 for whom birthplace was known, non–US-born new school entrants had nearly a 5 times greater risk for tuberculosis disease than US-born new school entrants (0.07% vs 0.01%; relative risk: 4.9; 95% CI: 3.5–6.8).

Estimated Minimum Cost of Excess Testing

The proportion of new entrants to primary schools who were tested remained virtually unchanged after implementation of the health code amendment to discontinue testing of these children, 76.6% in 1991–1995 and 71.1% in 1996–1998. A small proportion of students, 7%, could not be classified because grade level was not reported or they were in a special education class. Thus, although it is possible that a number of children had personal risk factors unknown to investigators that would make tuberculin testing beneficial, as many as 241 570 new school entrants were unnecessarily tested between the 1996 and 1998 school years at a cost of >$5 million, or $128 311.75 per tuberculosis case prevented (Table 4). The direct medical expenditures for outpatient treatment of active tuberculosis were estimated at $1400 to $8000 per case, depending on drug susceptibility of the organism. Hospitalization charges per case were estimated at $18 588. The estimated minimum cost of $123 152.83 per case prevented far exceeded the cost of treating an active case.

DISCUSSION

The risk of TST positivity was low in primary school entrants in NYC and decreased significantly in both primary and secondary new school entrants after 1992. This decrease was consistent with the significant decline of active tuberculosis cases in NYC during this period. Tuberculosis cases in people of all ages dropped 65% from 3811 cases reported in 1992, the peak of the current epidemic, to 1332 in 2000. The number of tuberculosis cases in children

TABLE 4. Estimated Minimum Cost of Excess Tuberculin Testing Among Entrants to Primary Schools, NYC 1996–1998

Item	Unit Cost	No. of Children	Total Cost
Tuberculin testing	$ 15.00	241 570	$3 623 550.00
Diagnostic workup for TST+ students	$140	3170	$ 443 800.00
9 mo isoniazid therapy	$630	2536	$1 597 680.00
Total cost	—	—	$5 665 030.00
Number of cases prevented*	—	46	—
Cost per case prevented	—	—	$ 123 152.83

* 75% (2.42% of 2536).

younger than 20 years also decreased from 193 in 1992 to 124 in 2000. In 2000, NYC's tuberculosis case rate was 16.6 cases per 100 000 people, compared with 52.0 in 1992. After 1996, when the health code was revised to screen only new entrants to secondary schools, both the incidence and case rate dropped an additional 35%. The decrease in tuberculosis case rates was seen in all health districts in NYC during the decade.

Despite the low risk of infection, the change in the health code to discontinue TST among low-risk primary schoolchildren did not result in a decrease in testing, thus maintaining a high cost per case prevented. The screening of low-risk children continued despite widespread communication of the change to both providers and parents. At the beginning of each school year in 1991–1998, a newsletter was mailed by the health department to medical providers in NYC addressing issues related to school health and requirements for evaluation of new entrants, such as immunization schedules and TST screening. Immediately after the change in the tuberculin testing requirements in 1996, a special issue of the newsletter was distributed featuring the change and outlining the reasons for this change. In addition, public service announcements were broadcast on radio and television before the start of the school year in 1996. Subsequently, each year the newsletter referred to tuberculin testing as a requirement only for new entrants to secondary schools. Parents also received a copy of this newsletter each year along with a standard medical information form that was to be completed by the medical provider before a child began school. However, some of the persistence in testing may also be explained by the request for TST results on the medical information form. Providers may believe that children will be denied admission unless all boxes are filled in. This form has recently been revised to reflect the guidelines.

Lack of clinician adherence to screening and preventive guidelines is not unique to testing for tuberculosis infection and may parallel practices common to preventive screening guidelines in other disciplines. The benefits of screening guidelines in many areas of preventive care are well documented. However, studies evaluating the application of preventive service guidelines suggest that adherence is often poor, in part because their value may be poorly appreciated by clinicians.[17,18] A study of pediatricians' awareness of and attitudes about 4 clinical practice guidelines found that a relatively high proportion were aware of the clinical guidelines for managing hyperbilirubinemia, fever, and otitis media (50%–64%), but only 16% knew of preventive guidelines in these areas.[19] Although these studies point to lack of screening, overtesting, such as seen in tuberculin testing of NYC schoolchildren, may also result from a similar lack of appreciation of the loss of specificity of the tuberculin test when it is used in people who are at low risk for tuberculosis infection.

Another possible reason for continued testing of low-risk children may be that there is a lag between the actual and the perceived risk of tuberculosis infection in NYC. American Academy of Pediatrics guidelines that were current at the time of these tuberculin surveys stated that children who do not have specific risk factors and reside in high-prevalence areas should be tested every 2 to 3 years.[20] The 1997 guidelines also provided clarification of the 1994 guidelines clearly aimed at discouraging widespread application of tuberculin testing by defining "high-prevalence area" as follows: "In general, a high-risk neighborhood or community does not mean an entire city is at high risk; rates in any area of the city may vary by neighborhood or even from block to block; physicians should be aware of these patterns when determining the likelihood of exposure; public health officials or local tuberculosis experts should help physicians identify areas with appreciable tuberculosis rates."[21] In densely populated urban areas such as NYC, the definition of a "high-prevalence area" may not be easily determined, and although tuberculosis case rates have declined dramatically for the past decade, providers may still believe that the risk is high. Getting clinicians to modify testing practices as a result of changes in the epidemiology of tuberculosis will be difficult.

Growing evidence suggests, however, that a more targeted approach to tuberculin screening is valid[22–24] even in neighborhoods with higher tuberculosis incidence.[22,23] Two studies found that asking children and their caregivers about the presence of risk factors for tuberculosis infection, such as close contact with a person who has active tuberculosis, birth in or travel to an endemic region, or immune-compromising conditions, accurately identified children who would likely be infected.[22,24] One of these studies was conducted by Ozuah et al[22] in a NYC community where the tuberculosis incidence was 39 cases per 100 000 population in 1996. Tuberculosis case rates have declined significantly in NYC in most health districts since 1996. In 2000, only 1 health district had a case rate as high as that of the neighborhood in the study by Ozuah et al[22]: Central Harlem, which had an incidence rate of 39 cases per 100 000 population.[25] A recent study[23] of risk factors for LTBI among children in an NYC community with high tuberculosis incidence identified similar risk factors for infection as the criteria used in the risk assessment questionnaires. These studies convincingly show that risk factors for LTBI can accurately be identified through a screening risk assessment and that tuberculin testing of young children can be limited to those in whom such risk factors are identified. Some of the risk factors may be difficult to evaluate in some communities, however. For example, back-and-forth travel to areas where tuberculosis is endemic is frequent in some communities, and the frequency of testing required in these children is not clear.

Although testing of low-risk children continued, tuberculin testing of children who would benefit most was low. Tuberculin testing of new entrants to secondary schools increased slightly after the health code change; still, only 52% of these students were tested. The potential benefit of tuberculin testing in the older age group has been reported previously by and other investigators.[4,22] Previous analyses of the results of tuberculin testing of new school entrants in NYC[4] showed that a significant proportion, 10%, of new entrants at the secondary level were TST-positive. This proportion has remained at close to the same level in the years since the health code change. Ozuah et al[22] found that adding age >11 years to the risk assessment criteria for determining which children should receive tuberculin testing increased the sensitivity of the risk assessment from 85% to 96% and decreased the specificity from 86% to 61%.

Although older age was independently associated with having a positive TST in both US- and non–US-born children, new entrants to secondary schools, ie, children who were older at time of first entry to an NYC school, were more likely to be born in high TB incidence countries. Therefore, a majority of positive TSTs could have been identified following the current guidelines for tuberculin testing outlined in the 2000 Red Book, which recommends tuberculin testing only in the presence of specific risk factors, such as birth in a country with high tuberculosis incidence. In our results, 94.3% (4922 of 5215) of TST-positive new entrants >11 years old were non–US-born; >90% were from countries of high TB incidence. Our data suggest that being a new school entrant at the secondary level is a proxy for being non–US-born. Thus, age alone is not as important as being new to the NYC school system at the secondary level.

NYC experienced a significant influx of new immigrants from tuberculosis-endemic countries during the 1990s.[26] The NYC Health Code requirement for testing children who enter the NYC school system for the first time at the secondary level is reaching a high-risk group because the vast majority are new arrivals from countries where tuberculosis is endemic. For many of these new entrants, the medical evaluation required to enter school may be the first they receive. Additional analysis is needed to determine whether the testing mandate is providing an opportunity to identify immigrant children who are infected with tuberculosis and may not otherwise seek health care services. Identifying such children who would benefit from treatment of LTBI is important to NYC's tuberculosis control efforts. The means for ensuring treatment completion will need to be strengthened to achieve this goal.

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Celine R. Gounder, Cynthia R. Driver, Jerod N. Scholten, Huimin Shen and Sonal S. Munsiff

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